Fig. 11. Wing of *Gonomyia (Leiponeura) gladiator* new species.
Fig. 12. Wing of *Gnophomyia olssoni* new species.
Fig. 13. Wing of *Gnophomyia lachrymosa* new species.
Fig. 14. Wing of *Gnophomyia laticincta* new species.
Fig. 15. Wing of *Trentepohlia (Paramongoma) sororcula* new species.
Fig. 16. Wing of *Tanypremna fuscitarsis* new species.
Sc = subcosta; *R* = radius; *M* = media; *Cu* = cubitus.

OBSERVATIONS ON THE EGG-LAYING OF THE CADDICE-FLY BRACHYCENTRUS NIGRISOMA BANKS, AND ON THE HABITS OF THE YOUNG LARVÆ.[1]

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In the upland bogs near McLean, New York, there is a tributary of Beaver Creek that flows over a sediment-covered bed well shaded by trees, dashes into the open, over rocks and boulders for about fifty rods, then again disappears into the woods. In this restricted open area the square built cases of the larva of the caddis-fly are found attached to the upper surfaces of the stones in mid stream. Mr. J. T. Lloyd studied them here, and published a preliminary account of the habits of this species, with a partial life-history in 1915.[2] It is the purpose of this paper to record some further observations, especially upon oviposition and the habits of the young larvæ.

During the latter part of May, generally on the late afternoon of a clear day, females come out from hiding in crevices of the bark of the trees. Swiftly and warily they fly along the bank, just above the surface of the water. Then one will enter the water, and while

[1] Of the European species, Herr Georg Ulmer in "Die Süsswasser Fauna Deutschlands; Trichoptera," describes the immature stages of *B. subnubilis* and records that it inhabits sluggish waters, rich in plants. The larvæ build square cases at first, but older cases are often found with the corners rounded. The pupal cases are cylindrical. *B. montanus* inhabits rocky streams. The cases are regularly four-sided, made of small slender pieces of sticks, leaves, and bark. The pupal cases are the same kind.

[2] Pomona, Jour. of Ent., 7: 81–86, plate.

entirely or partially submerged, with no air evident clinging to the body, she will excitedly walk around over the stones from three to five minutes. Suddenly she rises and extrudes the egg mass, attaching one end to some support. This accomplished, she slowly and very weakly crawls from the water.

The egg mass, Fig. 10, consists of fifty to one hundred eggs embedded in a gelatinous matrix. The mass is dark-green at first, irregular in shape, three millimeters long by one and one-half wide. It soon swells to about three times its original proportions. A coating of sediment makes concealment almost perfect even while the mass waves to and fro in the current. The egg is dark-green and spherical.

Embryonic development is completed in from twenty-one to twenty-eight days. At the time of hatching, the abdomen starts to straighten, the legs are thrust downward and the chorion is ruptured in the region of the second thoracic segment, diagonally opposite the point of pressure of the legs and abdomen. With the raising of the head, the chorion is split still farther. Biting with the mandibles and pushing with the legs, the larva crawls out, leaving the exuvia inside the chorion. Examination of this cast skin shows a small chitinous tooth in the region of the clypeus. This so-called "hatching tooth," which, according to Siltala, is common to all Trichoptera, apparenly is not functional in this species.

The larvæ leave the egg mass at once, hastily scramble over stones and sticks into the quieter eddies close to the bank. There they feverishly set about case building. Chewing off a piece of plant material here, gathering a bit of bark or root fiber there, covering all with a generous supply of silk, they fashion splendid little cases. After the first row, which is more or less circular at first and is altered later, they are square in cross section. The larva holds the case with the mesothoracic legs, puts the silk-coated material in place with prothoracic legs, and tightly shoves it down with the metathoracic legs. Then the larva turns to the next side and puts on a piece of material there and so proceeds to each side in turn.

The cases are completed in about five hours. The larvæ then start to eat. For the first two weeks the food consists entirely of diatoms such as *Meridion, Cymbella, Navicula, Cocconema, Fragil-*

laria and *Synedra*. This food they obtain by browsing on the stones and vegetation over which they hastily scramble. At the end of the third week the green algæ *Œdogonium, Cladophora, Ulothrix, Cylindrospermum,* and bits of seed plants are added to the diet.

At the end of the sixth week, the larva is about three-sixteenths of an inch in length. It now possesses gills and a full armature of spines on the legs, such as is shown for front and middle legs in figures 5 and 7. The earlier condition of these same legs is shown in figures 4 and 6 of the plate. The larvæ now leave the quiet eddies along the bank, and concentrate on the upper surface of the current-swept boulders. There, with one edge of the front end of their cases firmly cemented to the stones, they face the current. With head thrust slightly forward, prothoracic legs extending straight ahead, mesothoracic legs upward, and metathoracic legs at the sides (figs. 1, 2), they wait for food.

From a purely herbivorous diet obtained by active searching, they now become mainly carnivorous, waiting in a most receptive attitude for whatever may come within their powerful grasp. An examination of the stomach contents at this time reveals small quantities of diatoms, slightly larger amounts of the algæ and tissue of higher plant and, by far the greatest in bulk, animal food such as May-fly nymphs of the genus *Heptagenia* and *Ephemerella,* Hydrachnids, Chironomid larva, small Crustacea, and even *Brachycentrus* larvæ. Fig. 12 is a diagram of the alimentary tract of a larva collected the latter part of September, when the predominance of animal food was at its maximum. Compared with that of a younger larva five weeks old (fig. 11), it shows the fore intestine enlarged and somewhat constricted in the center. The mid intestine is shorter and narrower, while the hind intestine is larger and relatively longer.

The spinning glands are very well developed, even when the larva leaves the egg mass. At the base of the labium the two glands join into a common chitinized duct which forms the silk press. This leads to an opening at the tip of the labium.

In the laboratory, larval habits were best observed by using a piece of thin glass tubing one-half inch in diameter. This was heated and carefully flattened on the top to prevent aberration. Inside the tube fine sand and small stones were attached to the bottom by means of commercial glass cement. A cap of ordinary window

screen fastened over the rear end of the tube prevented the larvæ from escaping and did not hinder the attachment of rubber tubing for an outlet. At the other end was fitted another piece of tubing which connected with a small glass funnel. This funnel was fastened just under the faucet. The desired amount of water could be easily regulated at any time, and the funnel furnished a means of introducing food.

Larvæ introduced into the stream passing through this tube soon attached their cases and assumed their characteristic attitude. Others were artificially fastened to stones in various positions. So long as the larvæ were facing the current, the legs were in the normal position. It did not seem to make much difference whether the larvæ were right or wrong side up in their cases. One specimen stayed ventral side up for over a week before it took the trouble to turn over. Those larvæ that did not face the current, after vain attempts to detach their cases, left them, and proceeded to build new ones. These they attached in the characteristic manner.

The larvæ apparently fail to recognize any food that is not moved into their grasp. *Cyclops* and water fleas, when held in the stream just in front of the larvæ, were absolutely ignored; but when allowed to float down with the current, were quickly seized and devoured. A waterflea, fully one-half the length of a larva was grasped and hugged bear-fashion by the legs that are all armed with powerful curved claws and strong spines (figs. 5, 7). Two very tough Hydrachnids suffered a like experience with the same larva. They were torn in pieces by the strong mandibles armed with sharp teeth (fig. 9) with a speed and regularity that well may be compared with a saw-mill.

Brachycentrus larvæ when placed in still water will assume their characteristic attitude of out-stretched legs. With *Cyclops* and water fleas within easy reach, passing to and fro, in and out of the case, not the slightest attempt was made to obtain a morsel. The current again started, however, the first unsuspecting intruder was caught and greedily devoured.

The spines on the femur of the meso- (fig. 7) and metathoracic legs (very similar) may serve as plankton seives. Finely powdered carmine introduced into the stream could be seen strained and caught on these. Then the short spines and row of long straw-colored hairs

on the inner edge of the femur of the prothoracic legs (fig. 5) were used to scrape off the particles and transfer them to the mouth parts. A subsequent examination of the stomach revealed the presence of the carmine there.

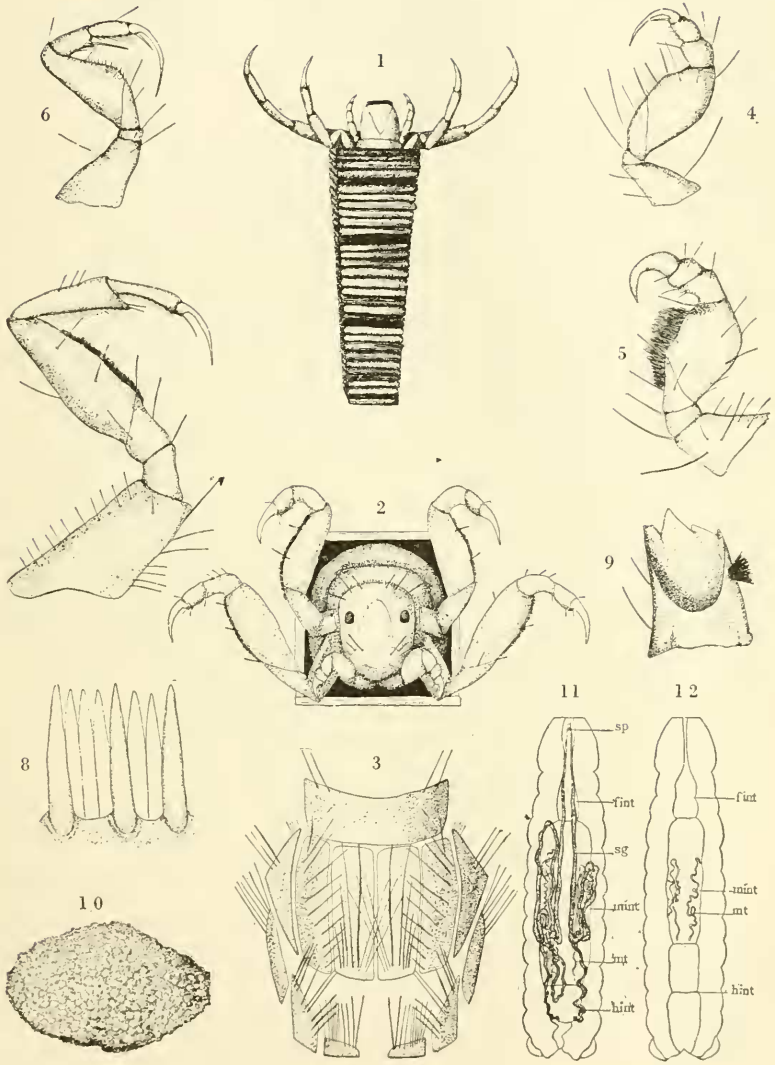
When a quantity of material, such as bits of plant tissue, pieces of wood, bark, or silt, was introduced into the stream, the larvæ would rear themselves out of their cases far enough to expose the entire thorax, and proceed to comb it with the mesothoracic legs in a single swift stroke. Then the prothoracic legs were used to remove the material and convey it to the mouth-parts, where it was as eagerly chewed as though it were the daintiest of morsels. Examination of the thorax (fig. 3) shows heavily chitinized pieces on the dorsum of the meso- and meta-thorax, bearing long forward projecting spines which overlap diagonally, forming a sort of meshwork above the thorax at the head end of the case. In-as-much as this habit seems prevalent, only at those times when the water contains a large amount of sediment and fine débris, it seems probable that the primary reason for this action is to keep the passageway open for a good stream of water through the case, and that the food-getting is a secondary matter and quite incidental.

Through the winter the larvæ feed but little, and then on diatoms mainly. With the lowering of the water after the spring freshets, during the middle of April, the larvæ fasten their square cases firmly to the stones. Then they feverishly set about spinning a silken sheet of lining, that is perforated in the center, at both ends. These tough cases may persist two or three seasons after the occupants have finished with them. Secure within their cases, the larvæ gradually go into a deep sleep and peacefully dream of becoming caddice-flies.

EXPLANATION OF PLATE XVIII.

Brachycentrus nigrisoma Banks.

Fig. 1. Dorsal aspect of larva in attitude of waiting for prey.
Fig. 2. Front aspect of larva in attitude of waiting for prey.
Fig. 3. Diagram of thorax of larva.
Fig. 4. Prothoracic leg of larva three weeks old.
Fig. 5. Prothoracic leg of larva four months old.
Fig. 6. Mesothoracic leg of larva three weeks old.
Fig. 7. Mesothoracic leg of larva four months old.
Fig. 8. Part of comb of mesothoracic leg of larva, in detail, four months old.



Brachycentris nigrisoma Banks